EFFECTS OF ATTRITION IN THE FLORIDA STUDY OF INTELLECTUAL ABILITY CHANGES IN THE ELDERLY

BY

GILLIAN SMOOK

A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1988

UNIVERSITY OF FLORIDA LIBRARIES

ACKNOWLEDGEMENTS

I wish to first thank my mother and father, Sylvia and Jan Smook, for their love, support, and faith in me.

Many thanks go to Dr. Walter R. Cunningham for his invaluable support and access to the data for the implementation of this research. I also wish to thank the other members of my dissertation committee, Dr. Patricia Miller, Dr. Richard Griggs, Dr. Scott Miller, and Dr. Jaime Algina, for their support, encouragement, and for their time and effort.

I never would have gotten this far in my academic career without the encouragement and support of Dr. Robert T. Brown and Dr. Joseph Kishton, as well as my many other supporters and friends among the faculty of the University of North Carolina at Wilmington.

I am also deeply grateful to my daughter and son-in-law, Deborah and Jay Twigg, son, Kenneth Cross, and my grandchildren, Patrick and Daniel. They deserve a lot of credit for being so supportive and encouraging while putting up with my living so far away and having a lot of

demands on my time. Dr. David Smook helped give me the will to get finished and the faith it could get done by receiving his doctorate before me.

Finally, I want to thank my many friends from the University of Florida, Yvette, Lewis, Darlene, Marite, Vern, Terry, Janet, Adrian, and Suzette for their support, help, and concern.

TABLE OF CONTENTS

PAGE

ACKNOWLEDGEMENTS ii

LIST OF TABLES v

ABSTRACT. vi

CHAPTER

I. INTRODUCTION. 1

II. METHOD 14

- Subjects 14
- Materials 16
  - Battery I 16
  - Battery II 17
  - Battery III. 17
- Procedure 21
  - Florida Study 21
  - Attrition Study. 23

III. RESULTS 28

- Retestee Versus All Dropouts 28
- Retestees Versus Still Alive Dropouts . . . 32
- Dropout Category Effects 32
- Dropout Category Effects With Education as Covariate 41
- Tests of Specific Comparison Hypotheses . . 43
- Summary of Results 45

IV. DISCUSSION 48

- The Problem of Attrition 48
- Minimization of the Problem 57
- Implications of the Problem for Research . . 61
- Conclusions 66

REFERENCES 68

BIOGRAPHICAL SKETCH 73

LIST OF TABLES

TABLE PAGE

1. Test Instruments and Related Information 18
2. Example of Instructions and Items on V5. 19
3. Examples of Items on N1. 20
4. Examples of Items on P2. 21
5. Attrition Groups and Their Characteristics 25
6. Age and Education Ranges and Proportion of Females in Five Categories 26
7. Significant Results from MANOVA With Deceased Dropped and for All Five Attrition Categories . . 33
8. Means and Standard Deviations of Age and Education Levels for the Five Attrition Categories. 34
9. Comparisons of Attrition Category Means and Variances on N1 37
10. Comparisons of Attrition Category Means and Variances on P2 38
11. Comparisons of the Means and Variances of Age Group by Attrition Categories With Retestee Category on V5 40
12. Analyses of Drop Categories With and Without Education as a Covariate for V5, N1, and P2. . . . 42
13. Separate Analyses by Age Group for V5 With and Without Education as a Covariate. 43
14. Summary Table of Hypotheses and Results. 47

Abstract of Dissertation Presented to the Graduate School
of the University of Florida in Partial Fulfillment of
the Requirements for the Degree of Doctor of Philosophy

EFFECTS OF ATTRITION IN THE FLORIDA STUDY OF INTELLECTUAL ABILITY CHANGES IN THE ELDERLY

By

Gillian Smook

August 1988

Chairman: Walter R. Cunningham
Major Department: Psychology

Attrition from the Florida Longitudinal Study of Intellectual Ability Changes in the Elderly was examined using measures of the identified intellectual factors of Verbal Comprehension, Number Facility, and Perceptual Speed.

There was evidence of a bias due to selective attrition. Continuing participants tended to be younger, better educated and more intellectually able than those who ceased to participate. However, this bias was not consistent for each of the intellectual abilities of interest. Verbal Comprehension and Perceptual Speed were more sensitive to this bias than was Number Facility.

Examination of differences between categories of original participants based on reasons for ceasing to participate found that not all the attrition categories had the same biasing effect. Those who ceased to participate due to relocation proved to have had similar scores to the continuing participants, except on Perceptual Speed. Except on Verbal Comprehension, those who ceased to participate because of ill health had shown performance levels that were similar to those who ceased to participate because of death. Both these groups had performed at lower levels than the continuing participants. On Verbal Comprehension, the young-old deceased had evidenced similar levels and the old-old deceased had evidenced lower levels of performance than the continuing participants. The category that presented the major bias on Number Facility was composed of those who had ceased to participate due to lack of interest or other demands on their time. On the other abilities, this category had performed at similar levels to the disabled.

Suggestions on how to minimize attrition are presented, and some the implications of the results of this study for research design were explored. The major conclusions were that there is a selective bias due to attrition, but that the degree of this bias depends on the particular measures of interest. Categorization of drop-outs provides a better understanding of the sources of attrition bias. Furthermore, the sources of attrition bias in longitudinal research may also be biasing the

alternative research methods. Therefore, the results of longitudinal research may be just as generalizable as results from the alternative methods.

CHAPTER I

INTRODUCTION

When a researcher is interested in investigating change in behavior over time, or as the subjects age, a longitudinal design is the only research method that will directly address such change. However, the longitudinal method is not without validity problems. Selective subject attrition has long been recognized as the major threat to the validity of longitudinal research designs (Baltes, 1968; Campbell & Stanley, 1966; Riegel, Riegel, & Meyer, 1967a). Attrition leads to smaller, more selected samples than had originally been selected for the research and thereby poses problems of the generalizability of the results (Norris, 1985; Schaie, 1982). That this threat is taken seriously in the field of sociology is reflected in the numerous articles devoted to procedures for tracking and retrieving longitudinal subjects (Crider, Willits, & Bealer, 1971; Eckland, 1968; Freedman, Thornton, & Camburn, 1980).

Some investigators essentially ignore this threat by using the data from only those individuals who continue to participate in the successive waves of the study (i.e.

Nelson, 1956), or by a brief mention of the possibility of bias due to attrition (e.g., Gribbin, Schaie, & Parham, 1980). Some investigators obtain new samples in order to replace dropouts (e.g., Milne & McKenzie, 1954). Other investigators have attended more to the possibility of bias due to selective attrition through analyses comparing various characteristics of dropouts as determined at prior assessments with those characteristics in the continuing sample.

The question of the possible bias in longitudinal research due to selective attrition has been investigated by researchers in many disciplines, and across many sample ages. A study of preschool performance over time on the McCarthy Scales found no evidence of bias due to a 15% attrition rate (Ernhart & Landa, 1980). However, selective subject attrition bias has been found in a study of adolescent drug use among ninth- and tenth-grade subjects (Brook, Cohen, & Gordon, 1983). Brook et al. found that continuing participants were more conventional, more achievement oriented, more likely to come from intact homes and to belong to conventional peer groups, and less likely to use drugs and show other deviant behaviors than those who dropped out of the study. Hansen, Collins, Malotte, Johnson, and Fielding (1985) found that tobacco and alcohol users were more likely than nonusers to drop out of tobacco and alcohol prevention studies in high school and junior high school. On the other hand, Kulka and Colton (1982) found no significant differences in their variables of interest in an 11-year longitudinal survey of post-college educated women even though there was an attrition rate of 46%. Thus we find mixed effects in the younger age ranges that seem to depend on the variables of interest.

However, there seems to be a greater potential for selective attrition biases in longitudinal studies of later life. Attrition problems may become more acute with older samples due to higher rates of illness, institutionalization, and death (Goudy, 1985), which results in a greater inability or unwillingness to continue to participate in a longitudinal study (Hertzog, Schaie, & Gribbin, 1978). This problem is further compounded by the finding that less-able persons die earlier or are more likely to become seriously ill (Riegel, Riegel, & Meyer, 1967b). "Since mortality itself is correlated with age, there is therefore reason to assume that positive selection factors may be of particular importance in the later parts of the life-span" (Schaie, Labouvie, & Barrett, 1973, p. 329).

Several studies have provided descriptions of the characteristics of the elderly who cease to participate in longitudinal studies. Hertzog et al. (1978) found that males with cardiovascular disease tend to drop out of longitudinal studies, while Gribbin et al. (1980) found that dropouts tend to be women characterized by the homemaker role, younger adults with high social status, and older adults characterized by disengagement and high family dissolution. On other social and demographic variables, dropouts have been found to have lower education levels and socioeconomic status, poorer health, greater social isolation, self-perceptions of being old, perceived inadequacy in income, and lower self-perceived health status (Rose, Busse, & Szretter, 1976), less favorable attitudes toward retirement, and less optimism (Streib, 1966). In addition, they are generally less able, hold less socially desirable attitudes, and show lower motivation (Schaie, 1982) than continuing participants.

Cognitive differences between those who drop out of longitudinal studies and those who continue to participate have also been found. Dropouts have been found to be characterized as adults who perform at lower levels than continuing participants on memory tasks (McCarty, Siegler, & Logue, 1982); are more rigid, dogmatic and negative to life; and have lower performance on intellectual tasks (Riegel et al., 1967a). Performance on the verbal, performance, and full scale Wechsler Adult Intelligence Scale (WAIS) has also differed between dropouts and continuing participants. Wilkie and Eisdorfer (1971) found that the continuing participants had higher Time 1 scores on the WAIS, as well as on the subscales, but the degree of difference depended on blood pressure. One explanation that has been offered for the difference between continuing participants and dropouts is the "terminal drop" or decline hypothesis which states that death is preceded by a decrease in cognitive functioning over a period of approximately five years (Riegel & Riegel, 1972), particulary in the younger elderly (Steuer, LaRue, Blum, & Jarvik, 1981).

However, not all longitudinal studies have found attrition to be associated with lower performances on cognitive or intelligence measures (i.e., Cunningham & Birren, 1976; Owens, 1966). In the Eisdorfer (1963) study, there were no significant differences in overall WAIS performance between returnees and nonreturnees in the under- 70 group, but nonreturnees 70 years old and over scored below the over-70 returnees. Age may have been the crucial variable in the Cunningham and Birren (1976) study since the mean age of the sample was 46.7 years. It has also been suggested that attrition may not pose as much of a threat if the original sample is educationally homogeneous (Witt & Cunningham, 1979), as the samples in these studies were.

Most studies reporting on attrition analyses have concentrated on comparisons between general dropouts and continuing participants. However, more recently, it has been suggested that there is a need for greater differentiation between different types of subjects who cease to participate in longitudinal studies (Cooney, Schaie, & Willis, 1985; Goudy, 1985; Norris, 1985). Norris (1985) suggested that selective survival and selective retest resistance may vary in their biasing effects on longitudinal data. Furthermore, Goudy (1985) suggested that there may be two basic types of attrition which may affect the major problem of the representativeness of the continuing sample in quite different ways. "Natural" attrition, which is attrition due to death, may not affect the representativeness of the sample with regard to the parent population to any great extent since the same types of attrition will be occurring in the parent population over the same period of time as the longitudinal study. Therefore, Goudy suggests that "unnatural" attrition, which is due to illness, refusal to cooperate and other conditions that are more within the experimenter's control, should be the focus of the investigations of the potential for bias in longitudinal data due to attrition.

Norris (1985) investigated the differential characteristics of five attrition types and their threat to the validity of a longitudinal study of a variety of sociological characteristics of an older sample. Dropouts were classified as (1) deceased; (2) disabled due to hospitalization, institutionalization, or other health problems; (3) hard-to-find; (4) disinterested due to being too busy, disapproval of the project, or simply not interested; (5) other, which were dropouts who were unclassifiable, subjects who had invalid or incomplete data, or those who simply declined to continue participation with no reason given. The deceased and disabled males had poorer health and were older than the continuing participants, the hard-to-find males had poorer health and were younger, while the disinterested males were similar to the continuing participants. The characteristics of the females were similar to those of the males, but were not as marked. Norris concluded that the deceased group was not a threat to the continued representativeness of the sample but that the disabled group was a threat in that the continuing participants were unrepresentatively healthy. The hard-to-find group was less of a threat but still presented some threat to representativeness, while the disinterested group presented little, if any, threat.

Cooney et al. (1985) investigated the differential performances on intellectual abilities of four attrition status types. (1) Voluntary dropouts were all those who withdrew for non-health-related reasons. (2) The disabled group was composed of those who withdrew for reasons of ill health. (3) The deceased group was self-explanatory. (4) The survivor group was defined as those who continued for the full term of the study. They found support for differences between dropouts and continuing participants, with dropouts functioning less adequately on such intellectual factors as Verbal Meaning, Number, and Psychomotor Speed at prior assessment times. However, their findings indicate that dropouts differ markedly in prior functioning depending on the reasons for attrition. Just as Norris (1985) found that the disinterested group was similar to continuing participants, Cooney et al. found that voluntary dropouts resemble survivors, with the exception that on Psychomotor Speed the voluntary dropouts had lower performance. Their conclusion was that voluntary dropouts did not bias the data as much as subjects who ceased to participate due to illness or death. There was also evidence that the prior performance of the disabled and the deceased groups varied by age group, with the disabled having functioned the least adequately of the young-old groups and the deceased having functioned the least adequately of the old-old groups on Verbal Meaning and Psychomotor Speed. This suggests that death and illness may be associated with different characteristics for these two age groups.

The present evaluation of the threat to longitudinal research posed by attrition is based on the data from the Florida Longitudinal Study of Change in Intellectual Abilities of the Elderly. In the Florida Study, a sample of retired persons was administered a battery of tests of intellectual abilities in 1976 and 1977 (Cunningham, 1980; Cunningham, 1981; Cunningham & Richardson, 1978). A seven-year longitudinal followup was conducted in 1983 and 1984. The results of this study have been presented at numerous conferences (i.e. Cunningham, Smook, & Tomer, 1986; Cunningham, White, & Smook, 1984). As might be expected, there was considerable attrition, which was due to a variety of reasons.

For the purposes of this investigation, those who did not participate in the longitudinal followup were compared on scores from the three intellectual ability tests that had been administered to all subjects during the 1976-1977 phase of the Florida Study. These tests covered the intellectual ability factors of Verbal Comprehension, Number Facility, and Perceptual Speed. In addition, those who did not participate were grouped based on reason for nonparticipation. One group consisted of those who died during the seven-year interval (deceased); a second group was composed of those who did not participate for health reasons (disabled); a third group consisted of those who did not participate due to lack of interest, who were too busy to participate, and other reasons that indicated that nonparticipation was the individuals choice (voluntary); a fourth group consisted of those who were unable to participate due to having moved (relocated). The main comparison group consisted of those who were retested (retestees).

Based on the assumption that attrition is a major threat to longitudinal research designs (Campbell & Stanley, 1966), an assumption that has received considerable, though not unanimous, support, it is expected that the continuing participants in the Florida Study will have shown higher levels of performance in 1976-1977 than those who ceased to participate. However, Goudy (1985) suggested that "natural" attrition does not pose a threat to the generalizability of longitudinal results but that the threat exists in the other sources of attrition. Therefore, the threat will be evaluated again, using only the data from the continuing participants and those who dropped out for reasons other than death. It is expected that similar differences in performance will still be found.

Cooney et al. (1985) and Norris (1985) found that dropouts differ depending on their reasons for ceasing to participate. Similar differences between attrition groups are expected in this investigation. The disabled and the deceased are expected to have shown similar levels of performance at the first phase of the Florida Study and to have had lower levels than the voluntary and retestee groups, which are also expected to have shown similar levels of performance.

Studies of Florida migration patterns have suggested that the elderly who relocate, particularly those who move out of Florida, are in poorer health and are more likely to have suffered bereavement than those who remain in state (Litwak & Longino, 1987; Longino, McClelland, & Peterson, 1980). These findings would lead one to expect that the relocated group may have performed at similar levels to the disabled group. However, Meyer (1987) has suggested that it is the healthy, more affluent individuals who are more likely to be mobile. In that case, one would expect the relocated to have performed similarly to the retestees. Both of these hypotheses need to be evaluated, especially since Longino's samples were primarily from the Miami area and may therefore show different patterns than a sample of the elderly drawn from the entire state.

This investigation is utilizing the scores from tests of three different identified intellectual ability factors. Evidence from other studies indicates that individuals with cardiovascular disease are more likely to drop out (Hertzog et al., 1978), and appear to be most impaired on highly speeded tests of cognitive ability (Botwinick & Storandt, 1974). Therefore, it is expected that the measure of Perceptual Speed will be the most sensitive to the threat posed by attrition, and particularly so due to the deceased and disabled groups.

Verbal Comprehension has been found to be a cognitive ability that seems sensitive to the influences of "terminal drop" (Birren, 1965, White & Cunningham, in press). This measure is also expected to show lower performances by the deceased group than the other attrition groups.

Many of the expected differences between groups and between abilities may depend on the ages of the individuals providing the data. Riegel et al. (1968) suggested that the under age 65 deceased group shows lower levels of performance but that over age 65 death may be much more random with regards to psychological variables. The sensitivity of Verbal Comprehension measures to the "terminal" decline phenomenon has been found to occur only for those below age 70 (White & Cunningham, in press). However, Cooney et al. (1985) found that the old-old in their deceased group had had the lowest scores on verbal meaning measures. Therefore two opposing hypotheses will be examined. First, it may be that of the deceased the young-old are the major source of attrition bias on measures of Verbal Comprehension. On the other hand, the old-old may be the major source of attrition bias among the deceased on Verbal Comprehension. The possibility of age group effects on the other intellectual abilities of interest cannot be ignored.

CHAPTER II

METHOD

Subjects

The Florida Longitudinal Study of Changes in Intellectual Abilities of the Elderly (Florida Study) began data collection in 1976 and 1977. At that time, 1064 elderly subjects were recruited through the cooperation of the American Association of Retired Persons (AARP) in 29 cities throughout the state of Florida. Those cities were Blountstown, Cocoa, Copeland, Coral Gables, Daytona Beach, Ft. Lauderdale, Ft. Myers, Ft. Pierce, Hollywood, Jacksonville, Key West, Lake City, Lakeland, Madeira Beach, Melbourne, Miami Beach, Moore Haven, Ocala, Orlando, Panama City, Pensacola, Perry, Pinellas Park, Pompano Beach, Sarasota, Tallahassee, Tampa, Tarpon Springs, and Winter Haven. Of the original 1064 recruits, only 987 provided complete enough data to be considered as the Time 1 sample. The ages of these subjects ranged from 51 to 92 years, with the mean and the median age of 68 years, and a mean education level of 12 years (3-22 year range). As might be expected in an elderly sample, 65% of the subjects were female.

The second phase of the longitudinal study was undertaken in 1983 and 1984. Elderly subjects from time 1 were mailed a letter explaining the nature of the study and its purposes and indicating the time and place at which the new testing would be conducted. This letter also indicated that participants would receive an honorarium of $12. A postcard was included so that probable attendance could be indicated, as was a letter from the National AARP president which endorsed the project and recommended participation. For those who indicated probable attendance, a reminder letter was sent one week before the new testing date. For those who did not respond or those who indicated nonparticipation, an additional letter was sent and/or one or more phone calls were made. Every effort, within the limits of professional ethics and common courtesy, was made to encourage participation in the group testings. Efforts were also made to identify and individually test persons who were not in the group testings. Individual versus group testing is not an important source of bias in this type of study (Owens, 1953). These recruitment procedures resulted in participation by 451 individuals (45.7% of the time 1 sample) in the second phase of testing and nonparticipation by 536 individuals.

Materials

Selection of testing materials for the Florida Study was made in the Thurstone/Guilford psychometric tradition with emphasis on the broad concept of intellectual funtioning as made up of a variety of factorially distinct mental abilities. Therefore, for the main study, 11 such factors were originally selected in order to yield a fairly extensive coverage of the intellectual functioning domain. There was an attempt to select variables that might be particularly sensitive to age changes or that might be resistant to age because of experiential influences. Of particular interest was the influence of speed requirements on age related change. Therefore, these 11 factors were arranged into three test batteries of different speed requirements.

Battery I

This battery consisted of tasks in which speed of response is a critical feature. This battery contained tests of Expressional Fluency, the ability to think rapidly of appropriate wording of ideas; Figural Evaluation, the ability to rapidly compare figural material; and Word Fluency, facility in producing isolated words that contain one or more structural, essentially phonetic, restrictions without reference to the meaning of the words. See Cunningham and Richardson (1978) for the time 1 results from this battery.

Battery II

This battery consisted of tasks where speed of response was intermediate. It contained tests of Flexibility of Closure, the ability to keep one or more definite configurations in mind so as to make identification in spite of perceptual distractions; Number Facility, the ability to manipulate numbers in arithmetical operations rapidly; and Symbolic Cognition, the ability to recognize words from incomplete or scrambled letters. See Cunningham (1981) for the time 1 results from this battery of tests.

Battery III

This battery consisted of tasks of various factors with low speed requirements. It contained tests of Semantic Redefinition, the ability to shift the function of an object or part of an object and use it in a new way; Sensitivity to Problems, the ability to recognize practical problems; Social Intelligence, the ability to understand the feelings and reactions of other people; and Verbal Comprehension, the ability to understand the English language. See Cunningham (1980) for the results from time 1.

Table 1

Test Instruments and Related Information

Test Name	Abbreviation	Factor	Source	Battery & Order		
				I	II	III
Advanced Vocabulary	V5	V	ETS	1	1	1
Advanced Vocabulary	V4	V	ETS		11	8
Addition	N1	N	ETS	2	2	2
Division	N2	N	ETS		6	
Subtraction and multiplication	N3	N	ETS		7	
Number Comparison	P2	P	ETS	3	3	3
Finding A's	P1	P	ETS	5	10	
Letter Comparison	P4	P	UF	13		
Word Arrangement	WA	Fe	G(ETS	4		
Simile Interpretation	SI	Fe	G(ETS	9		
Expressional Fluency	EXF	Fe	G(ETS	12		
Prefixes I	PR	Fw	UF	6		
Prefixes II	PR	Fw	UF	7		
Suffixes	SU	Fw	UF	11		
Identical Pictures	P3	FiE	ETS	8		
Judgement of Size	JOS	FiE	G	10		
Disemvoweled Words	DW	SyC	G		4	
Omelet	OM	SyC	G		8	
Copying Test	CF3	Cf	ETS		5	
Hidden Patterns	CF2	Cf	ETS		9	
Pertinent Question	PQ	Sep	G			6
Seeing Problems	SP	Sep	G			10
Gestalt Transformations	GT	Re	G			7
New Uses	NU	Re	G			9
Expression Grouping	EG	SI	G			4
Missing Pictures	MP	SI	G			5

Notes. a. The factor abbreviations follow the ETS system (French, Ekstrom, and Price, 1963), except for SI, which was hypothesized to be a complex Social Intelligence factor, SyC, which was hypothesized to be a complex Symbolic Cognition factor. and FiE. which was hypothesized to be a Perceptual Speed factor with figural content, hence Figural Evaluation.

b. ETS stands for Educational Testing Service Manual, Kit of Reference Tests for Cognitive Factors (French et al., 1963). UF indicates an unpublished test developed at the University of Florida by Dr. Walter R. Cunningham, while G indicates a test developed in the Guilford Structure of Intellect Project and published by Sheridan Psychological Services, Inc., P.O. Box 6101, Orange, CA 91617. G(ETS) indicates a Guilford test listed in the ETS Manual.

The specific tests for each factor, their source, and their order of appearance within each battery are shown in Table 1. As may be noted from Table 1, three tests appear in all three batteries in the same order (1,2,3). Those three tests were (1) Advanced Vocabulary (V5), a test of Verbal Comprehension; (2) Addition (N1), a test of Number Facility; and (3) Number Comparison (P2), a test of Perceptual Speed. Each of these three tests was not necessarily an integral part of each battery. They had been included in the order given to provide a larger sample data base for investigations such as this one.

V5 is a timed test, but the time allotted is more than enough to finish. It consists of two sets of 18 items each, and four minutes are allotted for each set. Table 2 provides part of the instructions and the practice example from this test.

Table 2

Example of Instructions and Items on V5

This is a test of your knowledge of word meanings. Look at the sample below. One of the four numbered words has the same meaning or nearly the same meaning as the word at the left. Indicate your answer by writing, in the parentheses at the right, the number of the word that you select.

attempt 1-run 2-hate 3-try 4-stop . . . .( )

Note. This table is a part of the instructions for V5.

N1 is a timed addition test, and the time allotted is usually not enough to finish all of the items. This test also consists of two sets of items, with two minutes allotted to solve 60 items in each set. Table 3 presents the practice problems from the instructions to this test as examples of the types of items involved.

Table 3

Examples of Items on N1

4	7	12	84	7	34	17	45	31	80
9	6	5	54	38	81	50	41	52	78
1	15	67	42	80	51	74	89	19	15

Note: These items are from the practice problems provided in the instructions for N1.

P2 is a highly speeded task involving comparisons of sets of numbers. It also consists of two sets of items, with one and a half minutes to solve 24 items for each set. The practice items from the instructions are provided as examples of items on P2 in Table 4.

In addition to these tests, a demographic questionnaire was used to gather information regarding age, education level, and related topics. At time 2, questions were also included requesting information regarding current health and health status during the intervening years.

Table 4

Examples of Items on P2

659_____659	7343801_____7343801
73845_____73855	18824_____18824
1624_____1624	705216831_____795216831
438_____436	971_____971
4821459_____4814259	446014721_____446014721
658331_____656331	5173869_____5172869
11653_____11652	6430017_____6430017

Note. These items are from the practice examples provided in the instructions for P2.

Procedures

Florida Study

Time 1 (1976-1977). Elderly subjects were tested in group sessions at 9:30 am at local meeting places in each city. Each testing lasted approximately two hours, with a break at about the mid-point to alleviate possible fatique effects (Cunningham, Sepkoski, & Opel, 1978). Each session began with an introduction by the examiner, either Dr. Walter R. Cunningham or one of his graduate assistants, which addressed the nature and the purpose of the project. Informed consent forms were then read and signed, and testing began. The testing session in each city consisted of either Battery I, Battery II, or Battery III. For each of the tests used, the test was handed out, and the test instructions were read aloud by the examiner while the participants read along silently from their copy of the test. When a part of the test instuctions included practice examples, subjects were given time to work the examples. Each part of a test was timed separately by the examiner according to the standardized instructions using a hand-held stop watch. The test was collected before the next test was handed out. At the completion of the testing, subjects were thanked for their participation.

Several weeks after the testing session, each participant was sent an honorarium of $5 and a limited report on their performance.

Time 2 (1983-1984). Rerecruitment was described in the subjects section.

Testing procedures were the same as time 1 with a few exceptions. First, the factor of Social Intelligence, with its relevant tests, was dropped from Battery III due to low split-half reliability (Cunningham, 1980). Second, examiners at time 2 were all female graduate research assistants to Dr. Walter R. Cunningham. Third, some subjects were tested individually or in pairs, usually in their own homes, due to their being unable to participate in the group testing because of illness, distance to travel, and/or date of group testing being inconvenient for them. Other than place of testing, the individual testings were identical to the group testings. Fourth, subjects were asked to rate their present health as well as their health over the previous 7 years. This health rating was a part of the demographic questionnaire. In addition, they were asked to complete a posttest questionnaire which was designed to elicit their perceptions of the testing situation. Finally, subjects received an honorarium of $12.

Attrition Study

After every effort had been make to encourage active participation in the Florida Study, further efforts were made to discover the reasons for nonparticipation. Those who had responded to recruitment procedures in the negative and who could not be persuaded to participate were interviewed by telephone concerning their reasons for nonparticipation, health status during the seven intervening years, and present health status. Those who had not responded at all to the recruitment procedures were followed up by the same telephone interview whenever possible.

A major effort was undertaken to obtain information on subjects from time 1 who were unlocatable at time 2. State Vital Statistics records were searched to determine possible death. City directories and city telephone directories were searched for new addresses and/or leads to close relatives. Any such leads were followed up by telephone calls. Names of missing persons were sent to the national AARP offices for assistance in tracing its members. When these sources failed to provide the necessary information, an attempt was made to locate and interview former friends, acquaintances, and neighbors who could provide information as to how these people might be located.

Based on the information, or lack of information, from these efforts, time 1 participants were classified into one of five groups. See Table 5.

Retestee. This group consisted of the 451 individuals who participated at both time 1 and time 2 of the Florida Study. The time 1 age range of this group was from 51 to 92 years (mean = 67.58) with levels of education from 4 to 22 years (mean = 12.83). Females made up 59% of this group. Good to excellent health was

Table 5

Attrition Groups and Their Characteristics

Group	Reasons for status	Number
Retestee	Total Participated T2	451
Relocated		
	Bad address, unlocatable	122
	Moved out of town	10
	Moved out of state	37
	Moving out of town, state	4
	Total	173
Voluntary		
	Not interested	23
	Too busy	21
	No reason	86
	Caring for sick relatives	13
	Recent bereavement	2
	Other	9
	Total	154
Deceased	Total	121
Disabled		88
	General poor health	43
	Senile	9
	Stroke	7
	Cardiovascular	5
	Arthritis, debilitating	4
	Eyesight, blind or almost so	17
	Institutionalized, not senile	2
	Cancer	1
	Total	88

reported by most of these retestees. Table 6 shows the age and education ranges as well as the proportion of females in this group.

Table 6

Age and Education Ranges and Proportion of Females in Five Categories

Category	Age Range	Education Range	Proportion Female
Retestee	51-92	4-22	.59
Relocated	55-87	6-18	.64
Voluntary	53-85	6-18	.74
Deceased	55-91	5-18	.45
Disabled	57-88	5-18	.72

Relocated. This group consisted of 173 individuals who had moved, or were in the process of moving, to a different location. The time 1 age range of this group was from 55 to 87 years (mean = 68.6) with an education level ranging from 6 to 18 years (mean = 11.7). Females made up 64% of this group. Of those in this group who were contacted, most reported generally good health. Table 6 shows the age and education ranges as well as the proportion of females in this group.

Voluntary. This group consists of 154 individuals who voluntarily dropped out of the longitudinal study due to a variety of reasons. See Table 2. The time 1 age range of this group was between 53 and 85 years (mean = 67.78) and they had a range of from 6 to 18 years of formal education (mean = 12.14). Females made up 74% of this group. As with the retestee and relocated groups, most individuals in this group reported good health. Table 6 shows the age and education ranges as well as the proportion of females in this group.

Deceased. This group consists of 121 individuals who died between time 1 and time 2. The time 1 age of this group ranged from 55 to 91 years (mean = 70.97) and their education level ranged from 5 to 18 years (mean = 12.21). Of this group, 44.6% were female. Table 6 shows the age and education ranges as well as the proportion of females in this group.

Disabled. This group consists of 88 individuals who declined, or were unable, to participate for health related reasons. See Table 2 for the number of individuals in each health category. The time 1 age range of this group was between 57 and 88 years (mean = 69.8) with from 5 to 18 years of formal education (mean = 12.17), and 71.6% were female. Table 6 shows the age and education ranges as well as the proportion of females in this group.

CHAPTER III

RESULTS

All the analyses reported here use the data collected at the first time of measurement, which was in 1976-1977. The one exception to this is 1983-1984 attrition status.

The subjects were classified as to age group, young-old and old-old, based on a median split which was at age 68 years. The young-old were age 68 years or younger, and the old-old were 69 years or older.

Retestee Versus All Dropouts.

Initial analyses which kept age as a continuous parameter showed an overall difference in age between those retested and those who dropped out [F (1, 965) = 13.86, p = .0002] with the dropouts having a higher mean age (69.08) than the continuing participants (67.58). There was also a difference between these groups' mean education levels [F (1, 945) = 14.57, p = .0001], due to the higher education level of the continuing participants (13.40) than the dropouts (12.01). Sex was not a significant factor in either of these analyses.

A multivariate analysis of variance (MANOVA) was conducted using the General Linear Models (GLM) procedure of Statistical Analysis System (SAS) due to unequal cell sizes. This analysis had the three tests, V5, N1, and P2, as within subjects dependent variables and overall attrition status (continuing participation and all dropouts), sex, and age group (young-old and old-old) as the independent class variables.

There was a significant between subjects effect for age group [$\underline{F}$ (1, 871) = 31.57, $\underline{p} < .0001$], with overall better performance by the young-old group than by the old-old group. There was also a significant between subjects effect for attrition status [$\underline{F}$ (1, 871) = 25.74, $\underline{p} < .0001$] due to higher overall scores for the retestees than for the dropouts. No significant main effect of sex was found, nor were there any significant between subjects interactions.

For within subjects effects, there was no main effect of tests. However the tests entered into a number of interactions.

There was a test by age group interaction [$\underline{F}$ (2, 870) = 11.81, $\underline{p} < .0001$], which was primarily due to there being no age group main effect on V5 while N1 and P2 showed sizable main effects of age group [$\underline{F}$ (1, 871) = 25.36 and $\underline{F}$ (1, 871) = 61.16, respectively, $\underline{p} < .0001$ for both]. The young-old had higher scores on N1 and P2 than did the old-old.

There was also a test by sex interaction [*F* (2, 870) = 33.85, *p* < .0001] which was due to the greater sensitivity of V5 [*F* (1, 871) = 14.41, *p* = .0002] and N1 [*F* (1, 871) = 13.30, *p* = .0003] to sex effects than P2 [*F* (1, 871) = 6.81, *p* = .0092]. Also, males had higher scores on V5 and N1, while females had the higher scores on P2.

Of greater interest was the test by attrition status interaction [*F* (2, 870) = 4.54, *p* = .0109]. This interaction was due to attrition status having a greater effect on V5 [*F* (1, 871) = 36.86, *p* < .0001] and on P2 [*F* (1, 871) = 18.26, *p* < .0001] than on N1 [*F* (1, 871) = 7.37, *p* = .0068]. In all these cases scores were higher for the continuing participants than for the dropouts.

Finally, test entered into a three way interaction with age group and attrition status [*F* (2, 870) = 3.95, *p* = .0195]. This interaction was due to the significant age group by attrition status interaction on V5 [*F* (1, 871) = 4.27, *p* = .0391], while there were no such interactions on N1 or P2. Since this was a three way interaction, a follow-up analysis of variance (ANOVA), once again utilizing the GLM procedure of SAS, was computed for V5 in order to clarify the reason for this interaction using additional available data that were excluded from the MANOVA due to some subjects not having completed P2. These ANOVA results showed a significant main effect of age group [$F = 4.71$, $p = .0302$], sex [$F = 12.33$, $p = .0005$], and attrition status [$F\ (1, 971) = 37.14$, $p < .0001$], as was expected since all of these variables had entered into interaction with test in the MANOVA. Generally, the young-old group, males, and retestees showed higher performance on V5 than the old-old, females, and dropouts. However, a significant three-way interaction between overall attrition status, sex, and age group [$F\ (1, 971) = 4.92$, $p = .0267$] was also found.

Follow-up ANOVAs of this attrition status, sex, and age group interaction were conducted for each age group separately. These analyses showed that, while there were significant effects of attrition status for both age groups [young-old $F\ (1, 522) = 10.47$, $p = .0013$; old-old $F\ (1, 448) = 29.73$, $p < .0001$], a main effect of sex was found only with the young-old [$F\ (1, 522) = 11.73$, $p = .0007$]. This sex effect on V5 was due to the overall better performance of young-old males. However, there was still a significant attrition status by sex interaction [$F\ (1, 522) = 6.66$, $p = .0101$] for the young-old, which was due to similar scores by males in both attrition classes but significantly lower scores by females who dropped out than by females who continued to participate.

Retestees Versus Still Alive Dropouts

It has recently been suggested that analyses for the biasing effects of attrition in terms of a threat to generalizability of results should not necessarily include the data from deceased subjects (Goudy, 1985). In order to determine the bias introduced to this longitudinal study by the nonparticipation of surviving subjects, the next set of analyses was similar to the analyses already reported, except that the data from deceased subjects were dropped.

The between subjects results indicated that the biasing effects of attrition were still present [F (1, 767) = 24.15, $p < .0001$], as was the age group effect [F (1, 767) = 21.59, $p < .0001$].

With regard to the within subjects effects, they were very similar to the overall attrition effects results with the exception that the three way interaction between test, age group, and attrition group was no longer found. See Table 7 for the F-statistics on these significant results.

Dropout Category Effects

Further analyses were conducted to try to determine the impact of dropout category on the results of longitudinal studies. These analyses were essentially replications of the earlier analyses reported here; but instead of having two classifications of attrition status, the five categories of retestee, voluntary, relocated, disabled, and deceased were used.

Table 7

Significant Results from MANOVA With Deceased Dropped and for All Five Attrition Categories

	Without Deceased			Five Category		
Source	*df*	*F*	prob>*F*	*df*	*F*	prob>*F*
Between subjects						
Age Group	1,767	21.59	.0001	1,859	24.23	.0001
Sex	1,767	2.40	ns	1,849	2.07	ns
Attrition	1,767	24.15	.0001	4,849	9.47	.0001
Age Group x Attrition	1,767	1.09	ns	4,849	3.14	.0140
Within subjects						
Test x Age	2,766	13.83	.0001	2,858	3.77	.0234
V5	1,767	.34	ns	1,859	3.57	.0592
N1	1,767	17.27	.0001	1,859	25.53	.0001
P2	1,767	50.45	.0001	1,859	61.60	.0001
Test x Sex	2,766	31.45	.0001	2,858	28.26	.0001
V5	1,767	12.95	.0003	1,859	14.63	.0001
N1	1,767	12.14	.0005	1,859	13.39	.0003
P2	1,767	5.95	.0149	1,859	6.86	.0090
Test x Attrition	2,766	4.08	.0172	8,1716	2.26	.0212
V5	1,767	37.09	.0001	4,859	13.40	.0001
N1	1,767	8.45	.0038	4,859	4.07	.0028
P2	1,767	16.68	.0001	4,859	6.61	.0001

Once again, a significant age difference between dropout categories was found [*F* (1, 959) = 7.85, *p* = .0001]. The deceased and disabled groups had the oldest mean ages. The voluntary, relocated, and retestee categories had the youngest mean ages. As with the analysis using overall dropouts and retestees, there were significant differences between categories on education level [*F* (1, 939) = 3.84, *p* = .0042]. The retestees had a higher mean level of education than the relocated dropouts. None of the other differences was significant. (See Table 8 for the mean ages and education levels of each category.)

Table 8

Means and Standard Deviations of Age and Education Levels for the Five Attrition Categories.

Category	Age	s.d.		Education	s.d.	
Retestee	67.58	6.19	c	13.40	2.96	a
Voluntary	67.78	6.41	c	12.14	3.09	a b
Deceased	70.97	6.75	a	12.21	3.09	a b
Disabled	69.78	6.19	a b	12.17	3.02	a b
Relocated	68.56	6.48	b c	11.69	2.64	b

Note: Categories with the same letters are not significantly different from each other.

As expected, the results of the overall attrition effects analyses were supported as was shown in Table 7. There was also a significant Age Group x Attrition Category interaction in the between subjects effects (see Table 7).

Since interpretation of the Test x Attrition Category interaction is not as simple for the attrition category analysis as it was for the attrition interactions in the previous analyses, ANOVAs were computed separately for each of the dependent variables. The separate ANOVAs also allowed the computations to take into account the data from subjects who were not included in the MANOVAs due to missing data on one or more of the dependent measures.

A main effect of age group was found for each of the dependent variables: V5 F (1, 952) = 4.76, $p < .0293$; N1 F (1, 956) = 22.64, $p < .0001$; P2 F (1, 873) = 52.31, $p < .0001$. On each of the dependent variables the young-old had higher scores than the old-old.

A main effect of sex was also found for each of the dependent variables: V5 F (1, 952) = 12,47, $p = .0004$; N1 F (1, 956) = 11.55, $p = .0007$; P2 F (1, 873) = 5.26, $p = .0220$. Males performed better on V5 and on N1 than females, while females performed better on P2.

Attrition category also showed a main effect on V5 [F (4, 952) = 12.54, $p < .0001$], N1 [F (4, 956) = 4.01,

$p = .0031$], and on P2 [F (4, 873) $= 7.63$, $p < .0001$]. However, each of the dependent variables showed a different pattern of significant differences between attrition categories. The T option of the SAS MEANS statement was used for the multiple comparisons of attrition group means since it performs pairwise t tests taking into account unequal cell sizes.

On N1, the voluntary group showed significantly poorer performance than the retestee, relocated, and the deceased groups. The disabled group also showed significantly poorer performance than the retestee group. There were no significant performance differences between the retestees, the relocated, and the deceased groups. However, only the retestees had performed better than the disabled group. See Table 9 for the means and variances on N1 for each attrition category. In addition to the statistical analyses for differences between the means, statistical tests for the homogeneity of variances were conducted. There was larger variability in the scores of the relocated than the retestees [F (168, 447) $= 1.25$, $p = .01$], and also in the scores of the deceased than of the retestees [F (117, 447) $= 1.24$, $p = .05$).

On P2, the retestee group had shown significantly better performance than the other groups. In addition, the relocated group showed better performance than the

Table 9

Comparisons of Attrition Category Means and Variances on N1

Category	n	Mean	Variance
Retestee	448	42.19 a	208.22 a
Relocated	169	41.05 a b	261.79 b
Deceased	118	40.69 a b	258.89 b
Disabled	87	37.80 b c	202.49 a b
Voluntary	154	36.53 c	225.90 a b

Note. Groups with the same letter are not significantly different from each other at alpha = .05.

disabled group. The voluntary, deceased and disabled groups did not have significant differences in performance. See Table 10 for the means and variances of the attrition categories on P2. Tests for the homogeneity of variances showed that there were no significant differences at the alpha = .01 level. However, at the alpha = .05 level, it was found that the relocated had less variability in scores than the voluntary [F (139, 154) = 1.46], the disabled [F (77, 154) = 1.45] and the deceased [F (105, 154) = 1.42]. In addition, the retestee category had less variability in scores than either the voluntary [F (139, 414) = 1.28] or the deceased [F (105, 414) = 1.24] categories. No other significant differences between variances were found for P2.

Table 10

Comparison of Attrition Category Means and Variances on P2

Category	n	Mean	Variance
Retestee	415	19.09	33.87 a c
Relocated	154	17.87 a b	29.59 a c
Voluntary	140	17.19 a b	43.30 b
Deceased	106	16.58 a b	41.99 b
Disabled	78	15.64 a	42.90 b c

Note: Groups with the same letter are not significantly different from each other at alpha = .05.

V5 showed, in addition to the main effects of age, sex, and attrition category, an Age Group x Attrition Category interaction [F (4. 592) = 3.46, $p = .0081$], which the other dependent variables did not show. Therefore, the main effect of attrition category will not be addressed. Instead, it is necessary to examine the differences between attrition categories while taking into consideration age group. First, separate analyses for young-old and old-old were computed which found that the patterns of attrition category effects at alpha = .01 were different for the young-old than for the old-old. With the young-old the deceased and the retestee categories had similar scores which were higher than only the scores of the voluntary and the disabled categories. The relocated category had similar scores to the deceased and the retestee categories. These scores were significantly different from only the disabled category. With the old-old, the retestee scores were similar to the relocated category scores but significantly higher than the disabled, deceased, and voluntary categories. The relocated category scores were significantly higher than only the deceased and the voluntary category scores.

Also simultaneous multiple comparisons of age group by attrition category were computed using a confidence intervals approach since the number of subjects in each comparison group was different. These results showed that at the alpha = .001 level, the young-old deceased, and both the old-old and the young-old retestees had similar performance levels and also higher performance levels than the old-old deceased, the young-old disabled, and the old-old voluntary. In addition, the young-old and the old-old retestee categories were significantly different from the young-old voluntary. The young-old relocated category was significantly different from only the old-old voluntary, while the old-old relocated category was not significatly different from any other category. To try to present a clearer picture of these differences with regard to the retestee category, Table 11 is provided. Tests for the homogeneity of variances showed that there were no significant differences at the alpha = .01 level or at the alpha = .05 level.

Table 11

Comparisons of the Means and Variances of Age Group by Attrition Categories With Retestee Category on V5

Category	*n*	Mean	Variance
Retestee			
Young-old	259	18.08	85.01
Old-old	188	18.31	84.82
Relocated			
Young-old	90	16.51	84.82
Old-old	81	15.82	101.00
Voluntary			
Young-old	84	13.79**	101.61
Old-old	65	11.10**	96.24
Deceased			
Young-old	48	18.62	103.02
Old-old	70	11.98**	103.63
Disabled			
Young-old	42	11.89**	68.56
Old-old	45	13.51	76.74

Note. ** denotes significance at the alpha = .001 level.

Dropout Category Effects With Education as Covariate

Reanalyses of the drop categories with education entered as a covariate changed only the results for N1 in any substantial way. However, the reduction in error, or unexplained variance, of the model which included education as a covariate was significant for V5 [F (34, 937) = 2.78, $p < .01$] and P2 [F (31, 861) = 2.44, $p < .01$]. The reduction in error on N1 [F (36, 939) = 1.21, $p > .05$] was not significant. See Table 12 for the results without and with education as a covariate.

On N1, the effect of drop category was no longer significant when education was covaried, even though education level itself did not have a main effect on N1. It seems evident that any effect of attrition on N1 is a by-product of the differences in education level between attrition categories. These differences between category education levels, while significantly reducing error, did not significantly ameliorate the effects of attrition category on either V5 or P2.

However, as may be noted in Table 13, education level differences between categories sizably reduced the main effect of drop category on V5 among the young-old, as well as significantly reducing the error in the analysis [F (14, 508) = 6.15, $p < .01$]. The main effect of drop category among the old-old was reduced by a much smaller amount and the reduction in error was minimal [*F* (20, 428) = 1.49, *p* > .05].

Table 12

Analyses of Drop Categories With and Without Education as a Covariate for V5, N1, and P2

	Without Education as Covariate			With Education as Covariate		
Source	*df*	*F*	prob>*F*	*df*	*F*	prob>*F*
Dependent Variable: V5						
Model	19,952	4.72	.0001	20,917	6.26	.0001
Age Group	1,952	4.76	.0293	1,917	5.69	.0172
Sex	1,952	12.47	.0004	1,917	7.47	.0064
Drop Category	4,952	12.54	.0001	4,917	6.61	.0001
Age Group x Drop Category	4,952	3.46	.0081	4,917	2.93	.0202
Education				1,917	45.43	.0001
Dependent Variable: N1						
Model	19,956	3.14	.0001	20,919	2.80	.0001
Age Group	1,956	22.64	.0001	1,919	15.42	.0001
Sex	1,956	11.55	.0007	1,919	9.52	.0021
Drop Category	4,956	4.01	.0031	4,919	1.73	.1421*
Age Group x Drop Category	4,956	1.60	.1730	4,919	1.19	.3127
Education				1,919	2.52	.1125
Dependent Variable: P2						
Model	19,873	5.33	.0001	20,841	4.94	.0001
Age Group	1,873	52.31	.0001	1,841	23.77	.0001
Sex	1,873	5.26	.0220	1,841	4.91	.0270
Drop Category	4,873	7.63	.0001	4,841	4.60	.0011
Age Group x Drop Category	4,873	1.39	.2366	4,841	.81	.5199
Education				1,841	4.01	.0455

Note: * designates loss of significance when education is a covariate.

Table 13

Separate Analyses by Age Group for V5 With and Without Education as a Covariate

	Without Education as Covariate			With Education as Covariate		
Source	*df*	*F*	prob>*F*	*df*	*F*	prob>*F*
Age Group: Young-Old						
Model	9,513	4.57	.0001	10,498	10.32	.0001
Sex	1,513	11.87	.0006	1,498	9.83	.0018
Drop Category	4,513	5.70	.0002	4,498	2.88	.0222
Education				1,498	57.59	.0001
Age Group: Old-Old						
Model	9,439	4.83	.0001	10,418	4.03	.0001
Sex	1,439	2.33	.1274	1,418	.44	.5087
Drop Category	4,439	10.12	.0001	4,418	6.44	.0001
Education				1,418	7.91	.0052

Tests of Specific Comparison Hypotheses

As can be noted in Tables 9 and 10, N1 and P2 scores of the deceased and disabled categories were not significantly different from each other. This lack of significance was supported by the results of ANOVAs computed specifically to test the hypothesis that these two categories would show approximately equal performances. However, part of the Age Group x Attrition Category interaction on V5 was due to the significant difference between the young-old deceased and the old-old deceased, as well as both the young-old and the old-old disabled. This difference between the deceased of the different age groups was also supported by the specific ANOVA which showed the expected Age Group x Attrition Category interaction [_F_ (1, 197) = 6.46, _p_ = .0118], as well as a main effect of age group [_F_ (1, 197) = 4.71, _p_ = .0312], and an Age Group x Sex interaction [_F_ (1, 197) = 3.93, _p_ = .0489]. The young-old had higher scores than the old-old, which was true mainly for the males. Part, but not all, of the differences in V5 scores between categories of the young-old age group was due to differential education levels.

The hypothesis of approximately equal performance of the retestee and voluntary categories was supported only for age. On education, N1, P2, and V5, the retestee category had significantly higher scores than the voluntary.

Given the similarity between the retestee and the relocated that has been found so far, ANOVAs were computed to specifically test for differences between these two categories. This similarity was maintained on N1. On V5, the specific ANOVA showed a main effect of category [_F_ (1, 610) = 5.19, _p_ = .0231], as well as a main effect of sex [_F_ (1, 610) = 4.25, _p_ = .0396]. The retestee category showed better performance than the relocated, and the males showed better performance than the females. On P2, the specific ANOVA showed a main effect of category [_F_ (1, 561) = 4.85, _p_ = .0281], a main effect of sex [_F_ (1, 561) = 6.80, _p_ = .0094] and a main effect of age group [_F_ (1, 561) = 42.68, _p_ = .0001]. Once again the retestee category showed higher scores than the relocated. However, females were better on P2 than the males. As might be expected of such a highly speeded task, the young-old did much better than the old-old.

Summary of Results

As had been expected, the biasing effects of attrition were found in all analyses. The performance of the dropouts was lower than the performance of the retestees. Also as expected, it was found that the amount of such biasing effects depend on the task and on the age group, especially on the measure of Verbal Comprehension.

The analyses using five categories based on reasons for dropping out showed that there were differences between these categories as far as presenting a biasing threat to the longitudinal results, as well as between the young-old and the old-old, and between tasks. However, the patterns of similarities and differences between categories, tasks and age groups were not as simple as had been expected.

The performances of the retestee and voluntary categories did not show the expected similarities. On the contrary, the voluntary category performance resembled that of the disabled group on V5 and P2 and had been significantly lower than even the disabled on N1. The expectation that the deceased and disabled would have shown similar levels of performance was only partially supported. These groups resembled each other on N1 and P2, but age group was an important factor in performance on V5. The young-old deceased had shown performance on V5 that resembled the performance of the retestees rather than the disabled. The relocated category had presented problems in developing clear cut expectations as to performance levels. Therefore alternative hypotheses had been examined. The performance of the relocated category resembled that of the retestee category more than that of the disabled.

On V5, the relocated category, the young-old deceased and the old-old disabled do not seem to pose a threat since their performance levels were not significantly different than the performance levels of the retestee category. The biasing threat to V5 seems to lie with the voluntary, the old-old deceased and the young-old disabled. On N1, the source of the biasing threat through attrition lies with the disabled and the voluntary categories, which had very similar levels of performance. This bias on N1 seems to be explained by the differential education levels among these categories. The main source of attrition bias in terms of task seems to be with the perceptual speed task. On this task the retestee category performed at significantly higher levels than any of the other categories. If any one category posed more of a threat than the others it would seem to be the disabled, which was significantly lower on performance than the relocated category and had the lowest scores on P2.

Table 14

Summary Table of Hypotheses and Results

Hypotheses	Variables		
	V5	N1	P2
Retestee > Dropout	+	+	+
Also with Deceased omitted	+	+	+
Differences among categories	+	+	+
Deceased = Disabled	OO	+	+
Retestee = Voluntary	-	-	-
Retestee > Disabled	OO	+	+
Retestee > Deceased	OO	-	-
Relocated = Disabled	-	-	+
Relocated = Retestee	+	+	-
P2 lowest for Deceased and Disabled	NA	NA	+
V5 lowest for Deceased	?	NA	NA
Among the Young-Old	-	NA	NA
Among the Old-Old	?	NA	NA

Note: + designates support, ? designates partial support, - designates no support, OO designates support in the Old-Old age group only, and NA designates not applicable.

CHAPTER 4

DISCUSSION

The Problem of Attrition

This evaluation of the threat to the generalizability of results from longitudinal research posed by attrition is based on data collected as part of the Florida Longitudinal Study of Intellectual Ability Changes in the Elderly. This study uses the scores from tests of three identified intellectual ability factors (French et al., 1963) that had been administered to a large elderly sample in 1976 and 1977. These tests represented the intellectual ability factors of Verbal Comprehension, Number Facility, and Perceptual Speed.

There was evidence of a bias due to selective attrition in all the analyses. In accordance with much of the research on attrition effects with the elderly (i.e., McCarty et al., 1982; Riegel et al., 1967a; Rose et al., 1976), and the hypothesis of this study, continuing participants generally tended to be younger, better educated and more intellectually able than those who ceased to participate.

However, Goudy (1985) suggested that evaluations of the representativeness of the continuing longitudinal sample should be done on the basis of the initial sample. Therefore, such evaluations should not include those who cease to participate due to "natural" attrition such as death. Norris (1985) has also suggested that there is a need to distinguish between the effects of subject loss due to selective survival of different populations and the effects of subject loss due to selective drop out:

> nonsurvivors do not affect panel representativeness in the same way as do those who drop out for other reasons.... Were death the only cause of panel loss, the sample whould continue to be representative of the surviving cohort. (Norris, 1985, p. 635)

As had been anticipated, even when the effect of attrition was examined with data from the deceased dropped, the same biasing persisted. Therefore there was evidence that surviving nonparticipants can be a major source of this bias.

However, this bias was not consistent for each of the intellectual abilities of interest. As had been expected, Perceptual Speed was more sensitive to bias due to attrition than was Number Facility. The finding that showed that Verbal Comprehension had similar sensitivity to attrition bias had not been expected. The sensitivity of Perceptual Speed to bias introduced through attrition did not depend on other variables, but the degree of bias on Verbal Comprehension depended on age group and sex. The 68 years of age or younger males showed no attrition bias, but the females of this age group who continued to participate had higher performance levels initially than the females who dropped out. Among the over 68 years of age group, all the retestees had shown higher initial performance levels than the dropouts. This pattern of ability specific biasing threat lends support to the Thurstone and Guilford tradition that intelligence is a composite of many separate abilities that can have their own separate trajectories.

It has been suggested that there is a need for greater differentiation between subjects who cease to participate in longitudinal studies (Cooney et al., 1985; Norris, 1985). Norris (1985) examined the bias due to reason for attrition with regard to such characteristics as age and health and found that the deceased and disabled males were older and had poorer health than the continuing participants, the unlocatable males had poorer health but were younger, while the males who dropped out due to lack of interest were similar to the continuing participants. The characteristics of the females were similar to that of the males but not as marked. On this basis, Norris concluded that, while the disabled and the unlocatable provide a threat to the representativeness of the continuing sample, the disinterested group did not pose a threat. Cooney et al. (1985) examined the bias due to attrition with regard to intellectual abilities and concluded that voluntary (disinterested) dropouts did not bias the data as much as subjects who ceased to participate due to illness or death. Cooney et al. also found evidence that suggested that death and illness may be associated with different intellectual characteristics among the young-old than among the old-old.

This investigation also considered the differential characteristics on prior intellectual measures due to reasons for nonparticipation as compared to continuing participation. The 1976-1977 participants were classified as retestees, voluntary, relocated, deceased, and disabled based on participation and reasons for nonparticipation in the 1983-1984 phase of the Florida Study. Sex and age group were also factors that entered into the examination of the data. The differential effects between intellectual abilites found in the global analyses were maintained in that the patterns of biasing depended on the particular intellectual ability test.

The findings of Cooney et al. (1985) that the voluntary dropouts resemble the retestees, with the exception of Psychomotor Speed performance, was the basis of the hypothesis that this resemblance would be found in the Florida Study. The hypothesis was not supported. In this study, the performance of the voluntary dropouts had not resembled that of the retestees on any of the measures. These findings may have differed from that of Cooney et al. (1985) due to inclusion of some different reasons for nonparticipation. It is not clear, but Cooney et al. may have included those who ceased to participate due to relocation in their voluntary dropout group.

One explanation of the lack of similarity between the retestees and the voluntary dropouts can be found in the statement made by one of these voluntary dropouts. She refused to continue participation because "there were too many things I want and need to do before I die." Others also made remarks that conveyed the impression of a final rush to do things that were important to them before they died or that they were involved in preparing themselves for their own death. While such statements are not clear evidence of nearness to death, there has been some evidence that the self-report of such feelings are as related to five year survival among individuals younger than 84 years of age as physicians' reports (LaRue, Bank, Jarvik, & Hetland, 1979). It may be that the elderly are especially sensitive to subtle physiological declines that make them very aware of the limits to their life span.

In the Florida Study, the voluntary group's initial performance had been significantly lower than the performance of the continuing participants on all the abilities under consideration, but particularly so with regard to the Number Facility measure. This group's performance had resembled that of the disabled group on the measures of Verbal Comprehension and Perceptual Speed but had been significantly lower than even the disabled on Number Facility. In addition, the mean education level of the voluntary category was almost identical to that of the deceased and disabled. However, when education level was taken into account in the analyses, the biasing effects of attrition on N1 were reduced to the extent that it was no longer significant.

Cooney et al. (1985) also found evidence that the disabled and deceased groups had functioned less adequately than the retestees but that they differed from each other with regard to age group. In their study, the disabled had functioned the least adequately of the young-old groups, and the deceased had functioned the least adequately of the old-old on Verbal Meaning and Psychomotor Speed. These findings also were supported partially. This investigation found that the disabled and deceased groups resembled each other on Number Facility and Perceptual Speed performance but that age group was important on the measure of Verbal Comprehension.

On Verbal Comprehension, the pattern of attrition bias was rather unexpected. The 68 years of age or younger deceased evidenced levels of performance that resembled the performance of the retestees, while the over 68 years of age deceased had shown significantly lower performance than retestees. This finding was unexpected since the terminal drop literature suggests that the young-old deceased should be the group that evidences decline prior to death (Riegel et al., 1968) and that Verbal Comprehension is a cognitive ability that seems sensitive to the influences of terminal drop (Birren, 1965), along with other aspects of verbal abilities (Siegler et al., 1982). However, White and Cunningham (in press), using the same data base as this investigation, found that the terminal drop phenomenon was only evident for the persons under 70 years of age and who had died within two years of the initial testing. The group who evidenced terminal drop was only a small subgroup of the young-old deceased group in this investigation. Cooney et al. (1985) had also found that their old-old deceased had lower verbal scores than their young-old deceased. It is widely recognized that there is a high correlation between education levels and performance on verbal measures. The young-old deceased in this investigation showed evidence of a mean education level that resembled that of the retestees, only slightly higher.

The degree of biasing in our longitudinal study was quite high due to those who ceased to participate due to disability and death, particularly on Perceptual Speed. It is highly likely that this effect on Perceptual Speed was due to the higher incidence of cardiovascular problems in these two groups initially than in the retestee or voluntary groups. Cardiovascular problems have been found to be associated with lower than normal performance on such measures (Hertzog et al., 1978, Wilkie & Eisdorfer, 1971).

A group not examined by Cooney et al. (1985), the relocated, presented problems to the development of a clear hypothesis as to its biasing effects. Studies that had data on health found that the hard-to-find (Norris, 1985) or the out-of-state movers (Longino et al., 1980), which are both incorportated in the relocated category inn the Florida Study, had poorer health than continuing participants or those who remained in the area. These findings would suggest that the performance of the relocated should resemble the performance of the disabled group. On the other hand, Meyer (1987) suggested that the healthy, affluent elderly are more likely to be mobile than the disabled and less affluent elderly. If the Florida Study relocated category had similar characteristics to the mobile in Meyer's study, then their performance should resemble that of the retestee category.

The hypothesis that the relocated category performance would resemble that of the disabled was clearly without support in the Florida Study data. Analyses computed to specifically test the alternative hypothesis of similarity of performance by the relocated and retestee groups evidenced partial support. The retestees had shown higher levels of performance on the measure of Verbal Comprehension as well as on Perceptual Speed. However, it is quite possible that this difference on Verbal Comprehension is negligible in that it only appeared to be significant in the more specific and therefore most sensitive analysis. The similarities in the performance of the retestees and relocated categories on Verbal Comprehension is remarkable since their mean education levels were so different. While the retestees had the highest education of all the categories, the relocated had the lowest level of education.

With the exception of the Perceptual Speed factor, the attrition bias introduced by relocated dropouts is negligible. The Florida Study results tend not to support the hypothesis based on the Norris (1985) and the Longino et al. (1980) findings.

Relocation proved to be a negligible source of bias due to attrition. Those who had moved, either out of state or in state or for whom we were unable to locate new addresses, presented the least biasing problems of all the categories. However, while the hypothesis based on the Meyer (1987) report was supported, the low mean education level of the relocated category in the Florida Study would seem to indicate less affluence since education is usually a good indicator of socioeconomic status. Therefore, there seems no justification to assume a higher level of affluence was the basis of the relatively high performance level of this group.

Golant (1987) suggested that environmental adaptations that are more consistent with their life styles and personal resources are sought by older people. This statement indicates that the reasons for relocation by the elderly may be very complex and that no description will generalize across research efforts.

Minimization of the Problem

Since attrition does present a problem in longitudinal research, particularly with regard to the relocated and the disabled, it is useful to consider ways that the rate of attrition might be minimized. Several of the reports from the field of sociology offer such suggestions.

Rose (1965) suggested that subjects for a longitudinal study can be selected on the basis of geographic stability, higher education, youth, and health in order to ensure continuing participation. However, these special characteristics in the subjects will serve to greatly reduce their representativeness. Given that such selective sampling may not be desirable, ways to maintain and to track original participants become important.

Freedman et al., (1980) maintained a 89% response rate over 15 years in a sample of women who had just gotten married or just given birth at the time of the first data collection. Freedman et al. had, at the initial contact, given great emphasis to collecting what they called facilitating information. In addition to the names and addresses of the subjects, they asked each woman to list the names and addresses of three friends or relatives with whom the subjects maintained frequent contact. During the 15 years, the principal investigators had established detailed procedures for keeping track of their subjects and of reestablishing rapport with these women. With regard to keeping track of their subjects, the facilitating information provided a good source of information if the subjects had moved away from the area. The reestablishment of rapport was greatly facilitated by the fact that the subsequent interviewers or solicitors of continued participation were supplied with all the needed information from previous contacts. Interviewer morale was also given a great deal of emphasis, as well as the value of the participants. While these procedures may not serve to maintain as high a rate of continuing participation with the elderly, my opinion is that they would prove worth the extra effort.

Eckland (1968) provided an excellent report on ways to track longitudinal subjects who have moved away in the intervening years. The postal services have a somewhat limited time of mail forwarding services. However, if certified mailing is used, the sender will receive information as to where the item was delivered. Eckland also suggests that local and regional coordinators of relevant organizations can provide information on missing subjects. Public records can also serve to provide some of the necessary information. Some of these sources were used to gain information in the Florida Study, though we did not think to check directories of professional associations or the department of motor vehicles. Eckland also stressed the importance of anchor points, such as date of birth, which can be very important when checking public vital statistics records and the names and addresses of close relatives.

Crider et al., (1971) had the greatest success rate in tracking prior subjects by visiting neighborhoods where the subjects had previously resided, contacting prior employers and schools their subjects had attended, and by utilizing long distance telephone calls to relatives and potential new locations. While some of these tracking methods are not as appropriate for the elderly as for younger samples, once again the usefulness of gathering information at the initial contact on close friends and relatives is supported.

During the course of working on the Florida Study during 1982 through 1985, my colleague, Nancy White, and I discussed the usefullness of maintaining a regular contact with prospective longitudinal subjects. We thought that something like sending a card to commemorate some yearly holiday could serve to keep the research team informed as to whether the person had moved, and if so, provide the team with a chance to update the records on new addesses before the expiration of the postal service forwarding service. Of course, having information on relatives in the records would also serve to facilitate subsequent contact.

Another way that the attrition rate can be minimized is to recruit subjects who are extraordinarily healthy, geographically stable, and motivated to continue their participation (Rose, 1965). This type of sample can introduce more threats to the generalizability of the results than is true of normal attrition.

Implications of the Problem for Research

The problem of attrition in longitudinal research has been widely recognized (ie. Baltes, 1968; Campbell & Stanley, 1963; Riegel et al., 1967a), but seldom, if ever, adequately dealt with (Hansen, et al., 1985; Streib, 1977).

Alternative designs exist that are assumed to be relatively free of the problem of attrition. One such alternative is the cross-sectional design. It, however, has a major problem in that the age differences it identifies may be actual age differences or may be cohort specific differences. The assumption has been that longitudinal designs are free of the cohort problem. Another alternative is the cross-sequential design, which allows one to identify the cohort specific effects on the basis of the longitudinal element and, theoretically, the attrition effects on the basis of the cross-sectional element. Can these designs actually deal with the problems that are found to be due to attrition? This question merits further attention.

First, I would like to address the assumption that the longitudinal design is free of cohort effects. Baltes (1968) suggested that the problem presented by attrition is that of selective survival and that the problem is further compounded if cohorts are subject to different underlying mechanisms that would lead to differential survival. Differential survival may well be the case. Demographics of the elderly have shown ever increasing survival in the elderly population as reflected by their ever-increasing numbers.

> In the U.S., the increase in life expectancy has been a result of major decline in circulatory disease mortality rates, most notably heart disease and stroke. Unfortunately only partly understood are the reasons for the decline in these causes of death . . . , their association with changes in chronic morbidity and disability in the population, whether they are likely to continue to any significant degree in the future, and what public health and biomedical strategies may promote further declines in mortality and maximize reductions in morbidity and disability. (Baum & Manton, 1987, p. 293)

As suggested by Baum and Manton in the quote, it is not clear what the association is between the decline in mortality and chronic morbidity and disability due to cardiovascular diseases. They have also stated that cardiovascular diseases are major causes of long-term and severe disability. There is also evidence that cardiovascular diseases are associated with impairment on the speed of psychomotor performance and on highly speeded tests of cognitive ability (Botwinick & Storandt, 1974; Hertzog et al., 1978). On these bases alone, it seems that longitudinal research may also have problems associated with cohort since such research will deal with populations in which the medical knowledge available at the time can be considered a historical event and the advances occurring in the medical field are substantial. Therefore, the results of longitudinal studies conducted with samples drawn from one, or even several generations, may not be generalizable to later generations with different life expectancies.

Attrition and its attendant problems are receiving renewed attention and being examined from new perspectives (Cooney et al., 1985; Goudy, 1985; Norris, 1985). As is evident from the research conducted by Norris (1985), by Cooney et al. (1985), and in this investigation, attrition due to disability introduces bias into longitudinal data. In addition, those who cease to participate due to lack of interest and related reasons also are a source of bias. However, most research depends on volunteers as subjects, and characteristics that appear in attrition in longitudinal research may well be operating in volunteering to participate. Differential volunteering may be especially true in research dealing with elderly populations. Characteristics that increase both the ease of finding participants and cooperativeness may well be overrepresented in voluntary participants in cross-sectional research, as well as in continuing participants in longitudinal research. Characteristics that decrease the ease of finding participants and/or cooperativeness may well mean they are underrepresented in most research. There is small likelihood that the disabled will volunteer for cross-sectional research. These same problems occur in cross-sequential designs, especially if one wishes to obtain new independent samples from the older cohorts in order to balance across age for those who dropped out. In addition, the deceased will not be available. So no matter what design is used, the subjects in research, at least with the elderly, will be the more able and healthier members of the population.

There is of course the question of whether voluntary subjects for longitudinal research may be, even initially, more selective than voluntary subjects for single occasion research. The answer to this question would depend on recruitment procedures and information, on continuing demands on time, and on the anticipated frequency of involvement. In longitudinal studies, such as the one in this investigation, greater selectivity of the initial sample should not be a problem. At the time of original recruitment, the longitudinal aspect of this study was not fully decided. Therefore, potential volunteers were not required to make a decision on long-term commitment. Selective volunteering may indeed present a generalizability threat if initial participation included considerations of long-term or frequent participation.

It is my opinion that conclusions about the aging process are just as valid, if not more so, on the basis of longitudinal research as on the basis of the alternative research methods. A longitudinal design allows one to directly address intraindividual change with age, whereas the cross-sectional design can only address differences across age.

In longitudinal research dealing with intellectual abilities of the elderly, it has usually been found that there are declines in performance. However, the longitudinal declines are usually smaller than the negative performance differences found between younger and older groups in cross-sectional designs. It has been suggested that the smaller longitudinal declines are due to the more intellectually able continuing to participate in the longitudinal studies while the less able drop out. But declines in intellectual performance, such as has been found with the Florida Study, may be more meaningful in that they do occur in spite of the positive selection bias of attrition and researchers do not need to make unexamined assumptions as to performance similarities at younger ages.

Neither the cross-sequential design nor the cross-sectional design eliminates the problem that becomes apparent with attrition. The longitudinal design gives the researcher the flexibility to examine the various characteristics of those who cease to participate and thereby arrive at a better understanding of the relationship between performance and nonparticipation in research.

Conclusions

Evidence was found that supports previous research findings of a selective bias due to attrition in longitudinal research. However, the degree of this bias was found to depend on which of three intellectual abilities were under consideration.

Categorization of dropouts according to reason for nonparticipation in continuing phases of longitudinal research proved to provide a better understanding of the sources of this bias. The threat posed by dropouts due to relocation is negligible on verbal and numerical intellectual abilities. However, there is a biasing effect of these dropouts on perceptual speed. The disabled bias the results on numerical, verbal and perceptual speed abilities. The deceased provide a similar bias, with the exception that on verbal ability it is only the older elderly who are the source of bias. Those who ceased to participate due to a lack of interest were a major source of bias on all three of the intellectual abilities considered.

Longitudinal research allows not only a direct investigation of changes with age but also the evaluation of some of the confounds with age that may enter into but are not apparent in some of the alternative designs. The results of longitudinal research may be just as generalizable, even given the problems of attrition, as research based on alternative designs.

REFERENCES

Baltes, P. B. (1968). Longitudinal and cross-sectional sequences in the study of age and generation effects. Human Development, 11, 145-171.

Baum, H. M., & Manton, K. G. (1987). National trends in stroke-related mortality: A comparison of multiple cause mortality data with survey and other health data. Gerontologist, 27, 293-300.

Birren, J. E. (1965). Age changes in speed of behavior: Its central nature and physilogical correlates. In A. T. Welford & J. E. Birren (Eds.), Behavior, aging and the nervous system (pp. 191-216). Springfield, IL: Charles C. Thomas.

Botwinick, J., & Storandt, M. (1974). Cardiovascular status, depressive affect, and other factors in reaction time. Journal of Gerontology, 29, 543-548.

Brook, J. S., Cohen, P., & Gordon, A. S. (1983). Impact of attrition in a sample in a longitudinal study of adolescent drug use. Psychological Reports, 53, 375-378.

Campbell, D. T., & Stanley, J. C. (1966). Experimental and quasi-experimental designs for research. Chicago: Rand McNally.

Cooney, T. M., Schaie, K. W., & Willis, S. L. (1985, November). Prior levels of performance as factors predicting subject attrition in the Seattle Longitudinal Study. Paper presented at the meetings of the Gerontological Society of America, New Orleans, LA..

Crider, D. M., Willits, F. K., & Bealer, R. C. (1971). Tracking respondents in longitudinal surveys. Public Opinion Quarterly, 35, 613-620.

Cunningham, W. R. (1980). Age comparative factor analysis of ability variables in adulthood and old age. Intelligence, 4, 133-149.

Cunningham, W. R. (1981). Ability factor structure differences in adulthood and old age. Multivariate Behavioral Research, 16, 3-22.

Cunningham, W. R., & Birren, J. E. (1976). Age changes in human abilities: A 28-year longitudinal study. Developmental Psychology, 12, 81-82.

Cunningham, W. R., & Richardson, P. C. (1978, August). Age differences in factor structure of highly speeded intelligence tests. Paper presented at the Meeting of the American Psychological Association in Toronto, Canada.

Cunningham, W. R., Sepkoski, C. M., & Opel,, M. R. (1978). Fatigue effects on intelligence test performance in the elderly. Journal of Gerontology, 33, 541-545.

Cunningham, W. R., Smook, G., & Tomer, A. (1986, November). Antecedants of intellectual change in old age. Paper presented at the 39th Annual Scientific Meeting of the Gerontological Society of America, Chicago, IL.

Cunningham, W. R., White, N., & Smook, G. (1984, November). Longitudinal losses in intellectual abilities in the elderly. Paper presented at the 37th Annual Scientific Meeting of the Gerontological Society of America, Houston, TX.

Eckland, B. K. (1968). Retrieving mobile cases in longitudinal surveys. Public Opinion Quarterly, 34, 51-64.

Eisdorfer, C. (1963) The WAIS performance of the aged: A retest evaluation. Journal of Gerontology, 18, 169-172.

Ernhart, C. B., & Landa, B. (1980). "Cumulative deficit," a longitudinal analysis of scores on McCarthy Scales. Psychological Reports, 47, 283-286.

French, J. W., Ekstrom, R. B., & Price, L. A. (1963). Manual for kit of reference tests for cognitive factors. Princeton, NJ.: Educational Testing Service.

Freedman, D. S., Thornton, A., & Camburn, D. (1980). Maintaining response rates in longitudinal studies. Sociological Methods & Research, 9, 87-98.

Golant, S. M. (1987). Residential moves by elderly persons to U.S. central cities, suburbs, and rural areas. Journal of Gerontology, 42, 534-539.

Goudy, W. J. (1985). Sample attrition and multivariate analysis in the Retirement History Study. Journal of Gerontology, 40, 358-367.

Gribbin, K., Schaie, K. W., & Parham, I. A. (1980). Complexity of life style and maintenance of intellectual abilites. Journal of Social Issues, 36, 47-61.

Hansen, W. B., Collins, L. M., Malotte, C. K., Johnson, C. A., & Fielding, J. E. (1985). Attrition in prevention research. Journal of Behavioral Medicine, 8, 261-275.

Hertzog, C., Schaie, K. W., & Gribbin, K. (1978). Cardiovascular disease and changes in intellectual functioning from middle to old age. Journal of Gerontology, 33, 872-883.

Kulka, R. A., & Colton, M. E. (1982). Secondary analysis of a longitudinal survey of educated women: A Social Psychological perspective. Journal of Social Issues, 38, 73-87.

LaRue, A., Bank, L., Jarvik, L., & Hetland, M. (1979). Health in old age: How do physicians' ratings and self-ratings compare? Journal of Gerontology, 34, 687-691.

Litwak, E., & Longino, C. F., Jr. (1987). Migration patterns among the elderly: A developmental perspective. The Gerontologist, 27, 266-272.

Longino, C. F. Jr., McClelland, K., & Peterson, W. (1980). The aged subculture hypothesis: Social integration, gerontophilia, and self-conception. Journal of Gerontology, 35, 758-767.

McCarty, S. M., Siegler, I. C., & Logue, P. E. (1982). Cross-sectional and longitudinal patterns of three Wechsler Memory Scale subtests. Journal of Gerontology, 37, 169-175.

Meyer, J. W. (1987). A regional scale temporal analysis of the net migratation patterns of elderly persons over time. Journal of Gerontology, 42, 366-375.

Milne, R. S., & McKenzie, H. C. (1954). Straight flight: A study of voting behavior in the constituency of Bristol North East at the general election of 1951. London: Hansard Society.

Nelson, E. N. P. (1956). Patterns of religious attitude shifts from college to 14 years later. Psychological Monographs, __, 1-15.

Norris, F. H. (1985) Characteristics of older nonrespondents over five waves of a panel study. Journal of Gerontology, 40, 627-636.

Owens, W. A. (1953). Age and mental abilities: A longitudinal study. Genetic Psychology Monographs, 48, 7-17.

Owens, W. A. (1966). Age and mental abilities: A second adult follow-up. Journal of Educational Psychology, 57, 311-325.

Riegel, K. F., & Riegel, R. M. (1972). Development, drop and death. Developmental Psychology, 6, 306-319.

Riegel, K. F., Riegel, R. M., & Meyer, G. (1967a). Socio-psychological factors of aging: A cohort-sequential analysis. Human Development, 10, 27-56.

Riegel, K. F., Riegel, R. M., & Meyer, G. (1967b). A study of the dropout rates in longitudinal research on aging and the prediction of death. Journal of Personality & Social Psychology, 4, 342-348.

Riegel, K. F., Riegel, R. M., & Meyer, G. (1968). The prediction of retest resisters in research on aging. Journal of Gerontology, 23, 370-374.

Rose, C. L. (1965). Representativeness of volunteer subjects in a longitudinal aging study. Human Development, 8, 152-156.

Rose, C. L., Busse, R., & Szretter, W. T. (1976). The relationship of scientific objectives to population selection and attrition in longitudinal studies. The case of the Normative Aging Study. Gerontologist, 16, 508-516.

Schaie, K. W. (1982). Longitudinal data sets: Evidence for ontogenetic development or chronicles of cultural change. Journal of Social Issues, 38, 65-72.

Schaie, K. W., Labouvie, G. V., & Barrett, T. J. (1973). Selective attrition effects in a fourteen-year study of adult intelligence. Journal of Gerontology, 28, 328-334.

Siegler, I. C., McCarty, S. M., & Logue, P. E. (1982). Wechsler Memory Scale scores, selective attrition, and distance from death. Journal of Gerontology, 37, 176-181.

Streib, G. F. (1966). Participants and drop-outs in a longitudinal study. Journal of Gerontology, 21, 200-209.

Steuer, J., LaRue, A., Blum, J. E., & Jarvik, L. (1981). Critical loss in the eighth and ninth decades. Journal of Gerontology, 36, 211-213.

White, N., & Cunningham, W. R. (In press). Is terminal decline pervasive or specific? Journal of Gerontology.

Wilkie, F., & Eisdorfer, C. (1971). Intelligence and blood pressure in the aged. Science, 172, 959-962.

Witt, S., & Cunningham, W. R. (1979). Cognitive speed and subsequent intellectual development: A longitudinal investigation. Journal of Gerontology, 34, 540-546.

BIOGRAPHICAL SKETCH

Gillian Smook was born in the, then, Union of South Africa to native born South African parents in 1941. In 1948, the Smook family emigrated to the United States in order for her parents to continue their education.

During her school years, Gillian attended many different public schools in several areas of Missouri and in different parts of Toronto, Canada. They say a rolling stone gathers no moss, but a moving child can gather a lot of learning by experiencing many educational settings and opportunities. This nomadic life was probably responsible for her turning into a bookworm, since books are very portable "friends."

Gillian was fortunate in being able to complete her last three years of public education at a very highly rated high school in Webster Groves, Missouri. From high school, Gillian went on to an unfortunate one and a half years at Drury College in Springfield, Missouri, that ended in an unhappy 20-year marriage. Her main accomplishment during her years of marriage was the production of two magnificent children, Deborah and

Kenneth Cross, that now, as adults, fill her with pride. In 1963, she decided to accompany her children in their American citizenship and became a citizen of the United States herself.

Upon the breakup of her marriage in 1979, Gillian returned to an academic career with the help of vocational rehabilitation. At the University of North Carolina at Wilmington, she had excellent opportunities and challenges to further her education. In 1982, she received a Bachelor of Arts degree in psychology and philosophy. During this time she also became the grandmother of two delightful male "developmental" subjects, Patrick and Daniel Twigg.

Then came a time of decision making, which ended with her making the choice to get a graduate degree in psychology. She received her Master of Science degree in 1987 in developmental psychology from the University of Florida, Gainesville, Florida. She expects to receive her Ph.D from the same program in August, 1988.

Since August, 1987, she has been serving as a instructor of psychology at Francis Marion College, Florence, South Carolina.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Walter R. Cunningham, chairman
Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Patricia H. Miller

Patricia H. Miller
Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Richard Griggs

Richard Griggs
Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Scott Miller
Associate Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

James Algina

Jaime Algina
Professor of Foundations of Education

This dissertation was submitted to the Graduate Faculty of the Department of Psychology in the College of Liberal Arts and Sciences and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

August 1988

Dean, Graduate School